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ABSTRACT

This bulletin describes two exemplary mathematics programs in Oregon: the Math Lab at Mountain View Junior High School in Beaverton and the Academy Math Program at Jefferson High School in northeastern Portland. The Math Lab at Mountain View is a weekly supplemental unit that is integrated into general math and pre-algebra courses for seventh and eighth graders. After an overview of the program, the discussion focuses on positive attributes, the lab packet design, time and resources, teacher preparation and role, the lab day routine and structure, student discipline and consequences, student response, parental support, tangible results, and desired changes. The Academy Math Program at Jefferson, described in the second chapter, is part of a federally funded high school program designed to offer business math to potential dropout students. The emphasis is on training in problem-solving skills with broad applications in the business world, and on student involvement with community business people who serve as "mentors." Initial problems in implementation are discussed, along with the changes being considered for the 1985-86 program. The final chapter discusses how these two programs take advantage of recent research in mathematics education. Both programs emphasize cooperative over competitive learning and problem solving, though drill and repetition are still essential parts of the curriculum. Both programs have improved student performance in mathematics, and both promote student enthusiasm for math and for self-directed study. References and interviews are included, along with two appendixes providing sample materials from each program. (TE)

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Mathematics for the Eighties: A Study of Two Effective Math Programs

Patrick J. O'Connor

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Preface

Mathematics curriculum has been subject to considerable public scrutiny in the last twenty years. Critics of some math programs cite low student test scores and a lack of student comprehension of basic skills. Recent research has advocated an emphasis on general versus specific math applications, cooperative learning, and problem-solving as well as maintaining traditional math techniques such as drill in math programs.

This month we examine how two Oregon schools, a junior high school and a high school, have implemented innovative math programs with limited resources.

This Bulletin was written by Patrick O'Connor, an OSSC graduate research assistant. O'Connor is a graduate student in the Division of Educational Policy and Management at the University of Oregon.

Philip K. Piele
Executive Secretary

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Introduction

Over the past twenty years, mathematics curriculum has reflected various educational trends, including new math, back-to-basics, as well as the most recent emphasis on problem-solving and "directed discovery." Despite these attempts to stay current with research on effective mathematics teaching, many educators believe that we are falling behind in keeping pace with society's demand of mathematical competence.

John Naisbitt, in Megatrends, identifies an evolving "information society" that will require individuals to cope with increasing amounts of data. Because of this "data overload," math students will have to become more adept at gathering, selecting, processing, and analyzing information. Presently, these needs are being inadequately met. Don Fineran, a mathematics education specialist at the Oregon Department of Education, echoes this concern:

> I fear much of our school mathematics is out of date in terms of what mathematics is actually needed by our students. I am especially concerned as to how they will be able to use this understanding as adults.

What are some of the implications of these challenges for the math programs of the eighties? How can math programs be significantly improved without investing an overabundance of time and money? Will these changes help students apply mathematical concepts

more readily to "real life"? What are some specific programs that have implemented some of these methods? These are some of the questions that will be explored in this Bulletin.

The first two chapters examine two particular programs--the Math Lab program at Mountain View Junior High School in Beaverton and "Academy Math" at Jefferson High School in Portland. The final chapter assesses how some of these programs' methods are supported by recent math research.

Math Lab
Mountain View Jr. High School

Mountain View Junior High School is one of six junior high schools in Beaverton School District 48J. Residing near the southwestern boundary of Beaverton, the school is an expansive, single story structure serving approximately 840 students in the seventh, eighth, and ninth grades. The surrounding area, decidedly suburban with a number of apartment buildings, is composed of a middle to upper-middle-class population. Rod Kvistad is the principal of this growing junior high school.

Overview of Math Lab

The Math Lab program is a weekly supplemental unit integrated into the majority of general math to pre-algebra courses at Mountain View. Seventh- and eighth-grade students attend the lab once a week as a part of their traditional math class. Adjustable partitions in the lab make it possible for teachers to combine class sections; up to seventy-five students can attend. The purpose of the lab is to help teachers provide their students with a variety of desired experiences that were, until this time, unavailable because of a lack of time, energy, and materials. Specifically, these experiences include "hands-on" activities, cooperative learning exercises, and improvement

of visualization skills. Because students work as partners in the lab, they receive constant feedback from their peers and learn the value of cooperation. In all, those involved with the lab agree with mathematics teacher Bonnie Mellow that this resource "has been successful in enriching our program, improving student attitude, and developing mathematical skills."

The Math Lab program at Mountain View Junior High School began because of the ideas and efforts of two math teachers: Bonnie Mellow and Kathy Pfaendler. Initial response to the program indicated that lab use would be limited to the original creators and not play a significant role in the junior high's math program. Two years after its introduction in winter quarter 1978, the program started to grow and has now become a popular and effective method of promoting student achievement and understanding of essential math concepts.

Positive Attributes

The rapid growth of the Math Lab can be attributed to several different factors. First, unlike many other innovative programs, this lab requires little, if any, additional funding and no additional staffing. Second, administrators and teachers support the program because, as Mellow explains, "they get positive feedback from students who are becoming more positive about math." It also has a beneficial influence on them for the teachers' other classes.

Third, the program is "economically sound" in that duplication of supplies and equipment is limited. For example, instead of buying twenty-five games, one for each child in a section, "you can get by with two sets of the materials and run 600 kids through the program,"

Pfaendler states. This degree of economy is especially important since the program is gaining popularity. Fourth, the program is flexible enough to take into account student mastery level, various teaching styles, and shifting scheduling requirements.

Fifth, and perhaps most importantly, the Math Lab instills a cooperative atmosphere among students and teachers. Math teachers have an opportunity to discuss challenging experiences with their colleagues, and students have a chance to develop interpersonal communication skills while learning important math concepts. To demonstrate how the program attains these objectives, this discussion will include an explanation of the lab packet and an examination of the program's structure.

Lab Packet Design

Lab packets are designed to accommodate a wide range of student skill levels, from the very young pre-algebra students to those with low seventh-grade skill levels. According to a written description of the program entitled "Teacher Commentary," the packets are an integral part of the lab structure:

> Each quarter the students rotate through eight different labs. Each lab packet is designed to be completed by a team of two or three students within about fifty minutes.

Essentially, these packets are written with a five-grade span of applicability in mind. Pfaendler states that the writing style must be simple and direct; with content "we try not to assume prior knowledge of certain key concepts, so we work mostly with problem-solving." Another reason she prefers an emphasis on problem-solving in the lab is that the "gap of abilities between

students disappears when they are problem-solving, especially with visualization. They all seem to have a need here." Manipulative exercises in geometry, such as constructing a dodecahedron, "give them an edge in visualizing geometric concepts." (See Appendix A for a list of relevant sources for packet ideas.)

When developing lab ideas, both teachers ask themselves if the particular concept can best be taught in class or in lab. Sometimes the lab is used most effectively to reinforce ideas first discussed in class, but it is particularly suited for introducing abstract concepts. For example, Mellow states she always uses a lab exercise in shapes before gradually introducing Euclidean geometry in class. She believes that if students have concrete experiences to refer to when applying mathematical concepts to a problem, students will be more successful in applying these math principles later. Lab students who have taken tests such as the MAA attest to the relevance of the lab exercises. Mellow reports that "almost every year there are problems on these tests that come directly from our math labs, including Pascal's Triangle and other exercises."

Time and Resources

Finding resources and time to develop labs is a major consideration in this program. A considerable amount of time is invested in this program, but both teachers feel that it is well worth the investment. Mellow admits, "It is often difficult to determine where work ends and the hobby starts." They both find great satisfaction in discovering an idea, developing it, and watching it work. Pfaendler notes that part of their interest in idea development

is that "it requires us to remain active learners, and if we remain active learners our students are much more likely to become involved in learning." As a result, Mellow and Pfaendler are always on the lookout for new ideas.

The lab has a large amount of resources available on accessible shelves. (Each lab packet has a bibliography at the end because the teachers like to give credit to the sources of an idea.) Both instructors spend a lot of time reading research materials, keeping current with recent innovations, and finding new ideas that can be used in class. Much of the resource material they receive from publishers at no charge. Mellow shares that many publishers are very cooperative in providing single copies of some informative works: "We wrote to numerous publishers and they were really good about sending entire packets." Both teachers believe that these free materials provide them with many good ideas they can integrate into their lessons.

Commenting on the use of textbooks as resources, both teachers stated that these books rely too much on "drill and practice." This format limits textbooks to a collection of worksheets. Mellow mentions that the state of California is trying an experiment whereby they would refuse to adopt any textbook that has drill-and-practice sets after sixth grade. This new requirement would be difficult to implement because not many textbooks have been made with this rule in mind. Pfaendler believes there may be a lag in producing the necessary materials, but they will inevitably be created. Especially important, both agreed, is that textbooks should have a balance between computational exercises and problem-solving.

Other valuable sources of ideas are math workshops and conferences, especially for discovering different teaching styles and perspectives. Some examples offered by Pfaendler include "meeting the child's needs," "left brain, right brain determination," as well as other viewpoints. She concludes that this program is strengthened by considering several different perspectives before implementing ideas. Even with all these ideas, she admits that "it takes an average of ten hours to develop an effective lab assignment."

Teacher Preparation and Role

In describing the logistics of the program, Pfaendler stated that interested math teachers meet at the beginning of the year to schedule the days and times they will be using the lab. Here they schedule their classes to attend math lab once a week. During this initial session, they discuss any necessary changes in the lab program and share ideas with other teachers. To accommodate different teaching styles and course curriculum, teachers are encouraged to supplement the basic lab packets for their particular groups and have the option of team-teaching this session or working independently.

With labs developed and times scheduled, room and material preparation are needed. Pfaendler stresses that this task should not rest on just a few teachers. Much of the lab planning is done at night and on the weekends. "It is especially important that work is delegated among those who use the lab." Since many of the packets and other assignments have already been created, much of this work delegation is lab maintenance.

Of course, this program requires more teacher time, even though

once the labs are established planning becomes less burdensome. Lab days take the most "in-class energy," Pfaendler believes, because the teacher spends much of his or her time attending to a multitude of tasks. Teachers try o resist giving the students quick answers, encouraging them to first reread the question and then talk it over with their lab partners and general group. As a last resort, the teacher guides student answers. Although this technique can be draining for the teacher, it is very rewarding for the student. Above all, Mellow and Pfaendler suggest teachers avoid the temptation of expediency, especially in the lab setting, so as not to compromise the atmosphere of discovery and creativity.

The extra effort becomes apparent in the students' ability to accept further refinements of general math principles. For example, Mellow contends that "introducing manipulatives at the right time can be especially helpful to students at the pre-algebra level...trying to make that tie between multiplying a number by two and 2n." Pascal's Triangle also provides a good introduction to base numbers. Pfaendler adds that most students will be using this particular triangle later in their second year of algebra.

With this program, teachers usually experience a role redefinition during the lab. Mellow admits that "a lot of teachers are not comfortable with a learning situation where the experience is not teacher-centered. The teacher in this program is a supportive person facilitating learning." Those desiring to implement a math lab program need to realize that the emphasis on cooperative learning requires flexibility in teaching and learning styles.

The lab structure does allow teachers an opportunity to make

one-on-one contact with their students. Pfaendler mentions that she really enjoys talking with students individually, finding out what's happening outside of class and reinforcing prosocial behavior with positive comments:

> Adolescence is the hardest time in a person's life, and yet at the junior high level we require that they take more classes at one time than they do at any other time in their entire life. It's really easy to get lost.

Both teachers believe that this once-a-week session helps them fill a student need that traditional classroom contact cannot provide.

Lab Day Routine and Structure

Course materials are arranged in separate tubs, each designated with a number and a letter to signify different activities. On lab days each student and his or her lab partner refer to a schedule sheet posted near the door to determine their weekly assignment. Upon learning the day's assignment, they find the appropriate tub, go to their assigned lab station--a table large enough for four people or four desks drawn together--and work upon the assignment as detailed in the work packets. Further details of the daily routine are outlined in Appendix B, which details student class responsibilities.

Both teachers agree that extensive "student inservice" is essential before attempting to implement the program. If this type of class is not structured and well organized, "you will have a chaotic mess," Mellow attests. Because students choose their lab partners, they often are tempted to socialize and not stay on task. In addition, Pfaendler stresses teachers should keep in mind that students will be involved in several different projects. Once the

quarter has begun, there is little opportunity to revise what has been initially outlined. She suggests that classroom control is essential, especially if one considers that there may be up to 75 students in the lab at one time.

Because adolescents are easily distracted from primary academic tasks, teachers employ grading as a form of accountability. Lab segment materials are corrected and graded, composing 20 percent of the total math grade since students attend the lab once a week. Mellow candidly acknowledges: "Let's face it, if you are the average thirteen year old, would you rather talk to the girl across from you or work exclusively with math concepts?" Pfaendler agrees, noting that "we've found that if the kids are not held accountable, they just don't do the work." Although students have plenty of initial enthusiasm for the lab, grading helps motivate students to achieve on a daily basis.

Student Discipline and Consequences

To maintain this high degree of control while students are experimenting with a variety of math concepts, discipline is an important part of this program. Mellow maintains that "one of the things that really helps the students learn in this lab is that we are really strict with students." They are not allowed to get up for the traditional reasons of asking questions, throwing away paper, or borrowing pencils. Unless the lab requires them to be up, they are to be seated and working on their assignment. Pfaendler offers the following rationale for this structure:

We have so much equipment, and we have kids all over the

> school doing various activities so that controlling their movement is very important. To keep track of these movements effectively, we require that they have a little blue pass found inside the appropriate packet which they need to hold where we can see it and we can check their progress. Unless we have this kind of system, many students just can't handle this program. This program is very structured, even though it appears to be rather loose.

The established rules and guidelines for the course seem particularly well suited to this program, which requires junior high school students to work with a measure of independence.

Students who violate these rules face consequences. One common transgression that must be attended to is misusing lab materials and equipment. Mellow states that "stacking cubes on top of one another to see who can build the tallest pyramid is a particular first quarter favorite." Most of the time the consequences include writing sentences, and if they don't complete these sentences (which hasn't happened yet), they are isolated from the lab. Pfaendler observes that there are

> fewer behavior problems during lab time because the students are actively involved in their work. No one has ever expressed a desire to be isolated from the lab, and I think that says a tremendous amount about the lab.

She suggests that peer support plays a large part in encouraging students to work cooperatively and in maintaining order.

Student Response

Overall student enthusiasm for the program rarely wanes. If a lab day is missed because of a holiday or special event, students will usually complain. Lab day, Pfaendler observes, "is easily their favorite day of the week largely because of the freedom they have to work in groups. For some people, talking and sharing is their

learning style." Students also demonstrate their appreciation of the program by attending lab after school, even when they have completed assigned math projects. They watch teachers plan, help generate new ideas, and bear witness to the discovery process inherent in problem-solving. These teachers are careful to model learning as a never-ending process. Mellow said that people often ask incredulously, "How can you teach junior high? Some think that all you are going to do is teach fraction problems and computation, and if that were the case, I wouldn't be working as a math teacher."

Part of the reason students have responded so favorably to the program is its emphasis on "cooperative learning," defined by Parker as "where students interact with one another in heterogeneous groups while working together on academic tasks." According to section III in the Student Inservice Sheet, students have the responsibility for choosing an appropriate lab partner and developing an effective working relationship. Many times students are much less intimidated to ask questions in a small group than if faced with raising their hand in class. Four students--two sets of lab partners--are assigned to each lab station. Because of a weekly shift in table assignments, there is constant revision in group dynamics. Although students are required to work with their lab partners, they are encouraged to share ideas with the other team at the station.

If the program is used to encourage creativity and resourcefulness, students respond much more positively to math. For example, students do a Euclidean construction unit right before Christmas, and the resulting projects, which are very colorful, can be taken home as tree ornaments. Earlier attempts to complete this

assignment had been considered "dry" by teachers and students alike. Mellow contends, "If we can make learning a little more interesting and fun, why not?" These units can be integrated with drill-and-practice units, creating a better balance in the program. Another exercise encouraging creativity and resourcefulness is "Simsoc," a simulated classroom society in which students become involved in elections, check-writing, small businesses, and other facets of consumer education.

Parental Support

Also reinforcing student interest in the program is parental support. Mellow and Pfaendler attest that parents speak favorably at "back to school" night and often work with their children on the assignments. As Pfaendler states,

> Sometimes they are skeptical about it--asking, "What does it have to do with reality?--because it sounds like too much fun, but after awhile they become more supportive, especially when they see their child makes sense of certain math concepts--then we have a supporter.

To increase the level of parental involvement, the teachers are presently researching a "family night" in the lab, an organizational model developed by researchers at the University of California, Berkeley. According to this concept, parents and students work together on math problems in the school lab. It allows parents and their child to work together on a similar level. Mellow senses a need for these events because she often gets calls from parents needing background information on the assigned projects to help their children. In all, students would be likely to benefit from this program.

Tangible Results

Those initially opposed to the lab program were afraid that it would lower test scores and diminish computational abilities. In contrast, recent test results indicate that overall test scores rose slightly because of an increased problem-solving ability. Recent research has also suggested that effective lab use is an appropriate method of enriching traditional math curriculum. One concrete example given by Mellow is that last year she was able to take all her students through LOGO with a limited number of computers. This task, she admits, would have been impossible in a traditional classroom setting.

Although the lab has enjoyed particular success, Pfaendler cautions that "I would never suggest a curriculum that did this more than once a week. You need a curriculum that provides a sense of closure and that is where traditional instruction comes in." This closure can be best attained by not teaching concepts as isolated units, but by including them in a developmental learning process. Both agree there is a tendency "to go overboard" with the math lab concept and lose sight of a comprehensive math program.

Desired Changes

As for desired changes in the present Math Lab, Mellow and Pfaendler cite lab staffing. Because the lab is open before and after school five days a week, monitoring lab facilities is an extra responsibility for teachers, most of whom teach six classes a day. Teachers often have other commitments during these "off" hours--giving

makeup tests and holding conferences--and are sometimes unable to supervise the lab. Mellow believes that community volunteers could be especially useful in this capacity. Clerical support would also provide teachers with much needed time for lab preparation and planning. "A one-half time clerical support person would be an immense aid to program efficiency," Pfaendler attests, "because we spend much time stapling and filing."

Teachers recognize the constant need for lab revision. "You can't afford to be stagnant with the program," says Pfaendler. Presently they are working on Algebra I packets because the present curriculum goes only as far as pre-algebra. Even though most seventh- and eighth-grade students are attending the Math Lab, Mellow and Pfaendler are attempting to accommodate "seventh grade students starting out in Algebra I." Both believe that the lab could be a significant addition to a junior high school program if there is a willingness and ability to devote significant time and energy to the process.

Conclusion

Although the Math Lab at Mountain View Junior High School has demonstrated its effectiveness as a worthwhile and economical math enrichment program, Mellow and Pfaendler contend that instituting and maintaining the lab is a time-consuming task. This potential obstacle, however, need not be insurmountable. With a committed staff, clerical support, and additional funding, this innovative program can be improved from its present high standard of excellence.

Academy Math Program at Jefferson High School

Jefferson High School is a large high school of 1,462 students in the northeastern portion of Portland School District 1J. Serving a low-income, ethnically diverse population, the school provides quality education in a facility originally built in 1908. Even though a series of inner-city school closings dramatically increased school enrollment over the past few years, student enrollment is now stabilizing. Under the leadership of Principal Nathan Jones, the school has implemented many innovative programs. The Academy Program is just one of these effective additions to course curriculum at Jefferson High School.

The Academy Math Program is part of a federally funded high school program designed to offer potential dropout students math of the business world. Intended to become self-sufficient after three years (it is now one year old), the program is a cooperative effort of the Portland Public Schools, the Urban League, and the local business community to encourage a select student population in developing essential business math skills.

Most of the funding for this program goes toward coordination, which is carried out by an Urban League representative, some business community contacts, and a teacher. Academy Math is one of three

components in the academy program, with Academy Communications and Academy Business being the other classes in the triad.

Candidates for Academy Math

Potential candidates for this program are students who have not "done well" their freshman year at Jefferson High School. These students do not include those with low skill levels or behavioral problems, but rather those who need some motivational stimuli. Thus these students are given a different approach to general math skills that will encourage them to become proficient with the concepts and tools needed in the business world. While grades are the primary determinant of admission, teacher recommendations and individual interviews are also taken into consideration. In its first year at Jefferson, the academy had thirty students enrolled in its three-component program.

Origins of the Program

According to Tom Swanson, the Academy Math teacher at Jefferson High School, the "academy" concept began in Philadelphia recently. To his knowledge, there are at least two branches on the West Coast: in Palo Alto, California, and in Portland. Although collaboration between the two branches has yet to become firmly established, Jefferson was recently visited by a representative from the Palo Alto school. It is Swanson's impression that the other school has a more traditional general math program than does Jefferson, and that Jefferson includes students with lower skills levels. Apparently California has seen promise in this program, for the state has agreed

to fund at least ten more academies in the near future. Presently, academy curriculum preparation is left to individual schools, and, in many cases, to individual teachers.

Focus on Problem-Solving and General Math Skills

According to Swanson, the academy math student needs particular training in problem-solving skills, and the course addresses this aspect of mathematics. He uses a variety of techniques to develop these skills, including relevant thought problems and computer games. Thought problems encourage students to use flexibility in applying math concepts, whereas computer games help stimulate interest in business math. Drill and hand-eye coordination exercises with calculators and computers also play an important role in the course. Swanson believes "it is essential that students should feel competent with the tools they will be using in business." Because of this orientation, students spend less time with traditional paper and pencil manipulation.

Although the Academy Math has a business emphasis, it is not to be confused with vocational courses that focus upon specific job requirements. Instead, this class instructs students in general math skills that have universal business applications. For example, Swanson cites fractions as being particularly important, specifically "where to put the decimal" in conversion.

Aside from its emphasis on business applications, the program also promotes student involvement with community business people. The Urban League representative assigns academy students to "mentors"--local business people willing to act as contacts for

interested students. This arrangement allows students to have firsthand business experience and helps reinforce the academic concepts they have learned in class.

Swanson says he has relative freedom in designing the math curriculum. He is working in conjunction with banks, insurance companies, and other community businesses in creating a relevant math program that will be useful to students in the business world. He believes that businesses have been "very happy" with the results of the program thus far and have encouraged students, especially by their participation as mentors.

Implementation Concerns

Instituting this program has not been without challenges. During the first year the coordination of different components of the program was difficult because of a lack of planning time. (The grant for this program was not approved until summer 1984, and the funds were not released until after school started in the fall.) Swanson cited one particular example of this problem during the Stock Market section. The program's communication, business, and math sections cover related material at different times in the year, weakening potential cohesiveness in the curriculum. Additional planning time should help alleviate these first-year problems.

Related to the lack of coordination, Swanson mentions that there needs to be more attention paid to effective test-taking skills, especially before standardized testing takes place. This alteration in the present curriculum could help improve the student exam performance on recognized quantitative tests of student knowledge. Even so,

academy students have already demonstrated higher scores in math than those in general math classes, according to Swanson's independent tests.

At the beginning of the first year, Swanson did not have text-books. Instead he used assignments from different sources to provide students with a variety of math perspectives. But students tended to lose the individual exercises, and replacing them wasted much time and energy. Midway through the year, however, he started using Math in Everyday Life, a consumer math workbook that provided some useful sections of interest. For example, the "check-writing" section is particularly helpful. In addition, the review sections provide needed reinforcement of key concepts and skill review.

Swanson now believes that using the book periodically gives some structure to the class and yet allows him to depart periodically for other topics he wishes to explore.

Considered Changes

Some changes for the 1985-86 school year's program are being considered. Presently, the three classes are given in sequence: periods 1, 2, and 3. During the next year, Jefferson is going to have academy classes meeting during periods 1, 2, 5 and 1, 2, 6 because of increased demand and because of attendance considerations. The school hopes to boost attendance of academy students during later class periods. According to Swanson, low attendance has been a concern in afternoon classes.

In addition, last year's emphasis was primarily on general math. This coming year, a pre-algebra section will serve those students who

have attained proficiency at the general math level. Swanson noted that this coming year he will have to deal with a broader range of skill levels, but does not believe this type of program growth will pose a significant problem.

Another factor that will improve the math component is more computers. This school year he will have twenty computers, compared to twelve last year. Because sharing machines is often counterproductive, he prefers one machine per student. Along with improved computer availability, he hopes to include more programming--Pascal and Basic--and use more statistics in the general math section.

Conclusion

The future of this program appears promising. Community response has been positive, even though many supporters do not have a clear picture of the academy concept. To clarify the intent and purpose of the program, Swanson hopes to involve the parents more this year. He is confident this inclusion will help reinforce skills being taught at school. In addition, as more businesses recognize the value of this program to the local economy, their support, especially in providing additional mentors, should enrich the Academy Program.

How These Two Programs are Consistent with Recent Research in Math Curriculum

Both of these innovative programs have taken advantage of recent mathematical education research. Specifically, they have become less attuned to "back to basics" singular emphasis on narrowly defined computational skills. Instead, these programs have a much more comprehensive scope. An article representative of broader skill considerations is the "National Council of Supervisors of Mathematics Position Paper on Basic Mathematical Skills." In general, this work proposes that

> the changing needs of society, the explosion of the amount of quantitative data and the availability of computers and calculators demand a redefining of the priorities for basic mathematical skills.

Cooperative Learning

Both programs exhibit a preference for cooperative over competitive learning. Separate research articles by Burns, Fletcher, and Wilson support the contributions made by cooperative learning, noting that this approach improves classroom climate and test scores, as well as basic understanding. The practitioners interviewed in this report attest that careful implementation and patience are essential for those trying this approach for the first time. Ruth Parker in

Small-Group Cooperative Learning in the Classroom (the March 1984 OSSC Bulletin), provides an informative introduction to cooperative learning and suggests some practical suggestions.

Problem-Solving

The content of these programs addresses an often neglected aspect of the math curriculum: problem-solving. By emphasizing problem-solving, the Math Lab and Academy Math maintain the position of the National Council of Teachers of Mathematics outlined in An Agenda for Action; the council suggests that problem-solving should be the focus of math in the 1980s.

Schaaf and Johnson both emphasize the role this skill should have in the schools. Schaaf concludes that "an examination of current math texts and the results of classroom visitations reveals that problem-solving is now only a minor part of mathematics instruction in both elementary and secondary schools." Johnson's guide, Math in Oregon Schools, echoes this concern, pointing out that "problem-solving is an important theme of teaching strategies and learning activities in response to developmental learning stages and secondly as a content strand."

Continued Importance of Drill and Repetition

Although problem-solving is a priority, both programs include drill and repetition as part of the curriculum. Mellow, teacher at Mountain View Junior High School, believes that some drill is essential to math, and Swanson, teacher at Jefferson High School, posits that student mastery of the calculator and computer cannot

happen without considerable machine exercises.

Saxon proposes the main defect of current math programs is a lack of review and repetition in classroom curriculum, especially in text-books. He recommends using "gentle repetition" for reinforcement, even though some critics charge that this "Skinnerian" perspective pushes students to do the same problem, instead of using the same skills over and over again (Mathis 1985). Both programs studied in this report take special care to use repetition for developmental purposes (for example, mastery of skills) instead of attempting to inscribe fixed procedural responses in students' minds.

Student Journals

Oscar Schaaf, director of the Lane County Math Project, suggests another approach to improving student learning without restructuring a present class. He refers to an article by Pradl and Mayher, who advise a more introspective approach. Their informative article illustrates how students can express their understanding of mathematic concepts learned in school by keeping journals of classroom experiences. This procedure, they point out, gives students a way of clarifying their thoughts and "a hot line...[of communication]...to and from the teacher." Perhaps, this approach can be used as a diagnostic tool or even as a method of building cooperation into a program.

Conclusion

The Math Lab at Mountain View Junior High School and the Academy Math course at Jefferson High School are two outstanding examples of schools willing to design courses to meet the special needs of their students. The Math Lab stresses cooperative learning, problem-solving, visualization, and diversification as a supplemental component to traditional math courses. On the other hand, Academy Math uses an effective combination of general math skills readiness, computer and calculator use, and community mentors to maintain a relevant curriculum for those students wishing to enter business.

These two programs have gained support from administrators, teachers, and parents for their positive influence on overall student test scores and student understanding of essential concepts in addition to their economical implementation costs. More importantly, however, they promote student enthusiasm for math and instill a desire for self-directed study long after students leave the programs.

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Don Fineran, specialist in math education, Oregon Department of Education, Salem, Oregon. Telephone interview, July 15, 1985.

Judy Mathis, Northern California Computer Math Advisory Board, Eugene, Oregon. Interview, June 25, 1985.

Bonnie Mellow, mathematics teacher, Mountain View Junior High School, Beaverton, Oregon. Interview, July 16, 1985.

Kathy Pfaendler, mathematics teacher, Mountain View Junior High School, Beaverton, Oregon. Interview, July 16, 1985.

Oscar Schaaf, director of Lane County Mathematics project and professor of education (secondary mathematics) at the University of Oregon, Eugene, Oregon. Interview, July 5, 1985.

Tom Swanson, mathematics teacher, Jefferson High School, Portland, Oregon. Telephone interview, June 26, 1985.

Appendix A

BIBLIOGRAPHY

Math Lab--Mountain View Junior High School

1	Mathematics Resource Project (especially Geometry)	Creative Publication
1	Math Lab Junior High	Action Math Associates
1	Oregon Math Teacher	NEA Press
1	Seeing Shapes	Creative Publication
1	Problem Solving	"
1	Handy Math Focus on Maps	"
1	Geo board Activities	"
1	Math Games	T O M
2	Activities in Mathematics (Pattern)	Scott Foresman
3	Aftermath	Creative Publication
2	Calculator Activities	Creative Publication
2	Math Inquiry Activities (Math Lab Kit I)	Educational Insights
2	Mathematics Around Us Grades 7 and 8	Scott Foresman
2	Math Imagination	Creative Publication
2	Mira - Junior High	Creative Publication
2	Problem Solving	Lane County Resource Center
2	Working Makes Sense	Fearon Publishers, Inc.
3	Art and Math	Action Math Associates
3	Mathematics a Human Endeavor	W. H. Freeman
3	Problem-Mathics	Creative Publication
3	The World of M. C. Escher	Harry N. Abrams, Inc.
3	Tesselation	Creative Publication

Appendix B

LAB INSERVICE FOR STUDENTS

Math Lab--Mountain View Junior High School

I. Overview

A. Why was the lab created?
   1. To help increase visualization skills.
   2. To better utilize our limited supplies (such as geo-board, miras, computers, calculators, attribute blocks, etc.)
   3. To promote enthusiasm for math.
   4. To give students exposure to working in groups and other math teachers.

B. About 5,000 have gone through the program.

II. What is the lab?

A. A hands-on approach to math.
   1. Numerous manipulatives and computers are used.

B. You work with a partner in groups of 2-4.

C. Variety of topics covered.
   1. drill and practice activities
   2. games
   3. discovery lessons
   4. geometry
   5. art work
   6. problem solving
   7. number theory
   8. computer abilities (logo)
   9. consumer topics, etc.

D. Lab is one day a week.
   1. Our day is (_____).
   2. We will be with (_____) class.

III. Picking a lab partner.

A. Pick someone you can work with and get along.

B. Try to choose someone who is at school most of the time.

C. Choose someone who will work for the same grade as you want.

D. Try to pick someone who will not be getting in trouble or getting you in trouble.

IV. Grades

A. Since we will spend one day a week on labs, the lab will count 1/5 of your quarter grade.

B. Each lab will be corrected and scored, and then returned to

one of the lab partners. (Note: students should keep their labs until the end of the term.)

C. Labs may be redone before or after school to receive a higher grade.

V. Makeup Labs

A. When you are absent, your lab partner does not put your name on the lab.

B. You are responsible to make up the lab before or after school.

C. All labs and makeups are due 1 week before the end of each quarter.

VI. Management

A. Roll (1st five minutes of class)
   1. Mark off the square directly across from your name (neatly with an "x").
   2. Never mark off your lab partner.
   3. Then go to the appropriate lab station.
      a. Do not ask your teacher where lab 3B is, just look.
      b. You have five minutes to mark off for roll and find your lab station and start to work.

B. At the lab station
   1. Take out one packet and put your name on it and have your lab partners put their names on it also.
   2. Check the outside of the folder to see if all the supplies needed are present and in good condition. If they are not, raise your hand to let your teacher know.
   3. Start to work!
   4. Stay in your seat at all times.
      a. If you are out of your seat for any reason--except for the first 5 minutes of class and the last 5 minutes of class--you will be assigned sentences ("I will remain at my lab station"--25 times).
   5. Questions (If you do not understand something)
      a. Ask your lab partner.
      b. Read the question again.
      c. Ask the two other people at your station.
      d. Lastly, raise your hand for help.
         --the teacher will ask you to read the problem aloud
         --then the teacher will ask you what is being asked
         --then they might underline a key sentence
         --In other words, we will not just give you the answer
   6. Respect all lab materials
      a. they cost a lot in time, money or both.
      b. no lab materials can be used in any way except for those designated in the lab packet or 100 sentences will be assigned ("I will use and respect lab material correctly").

C. Clean up (last 5 minutes of class)
   1. When the lights go off--stop whatever you are doing, look up and listen. (Note: do not start cleaning up until your teacher asks you to).
   2. Clean up lab box.
   3. Raise your hand when you are ready to be checked by your teacher.
   4. Turn in completed packets in the basket or give to your teacher.
   5. If you choose to take your packet home to finish it, they must all be turned in before the end of the term.
   6. Wait to be dismissed.

VII. Miscellaneous

A. 1A and 1B are the same labs.
B. All the lab boxes are color-coded.
C. Some supplies will have to be passed out each period and then collected at the end of the period.
D. Both people should work together on each page as opposed to splitting the pages.
E. Show some examples of art work, laminated paper, information sheets, etc.
F. 1st labs
   1. Clock Art
   2. Attribute Chain
   3. Map Skills/What makes a network work?
   4. Tricky Triangles
   5. Aire
   6. Palindromes
   7. What's your Angle?
   8. Computer (Logo)
G. Extensions on labs are extra credit, except for pre-algebra; these particular ones are required.
H. Seating arrangements-- 1 class rotates clockwise and the other class rotates counterclockwise, so that you should not end up with the same 4 people each time.
I. The room will be arranged in an L-shape and tables and desks will be set up for groups of four to work together.
J. Put the lab boxes on the floor after everyone gets here--so there is no temptation to write on it.
K. Some people will start with Lab 1, 2, 3, 4, 5, 6, 7, 8 and others will start on Labs 2, 3, 4, 5, 6, 7, 8, 1, etc.

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